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(54) [Title] MEDICAL IMAGE DIAGNOSTIC DEVICE

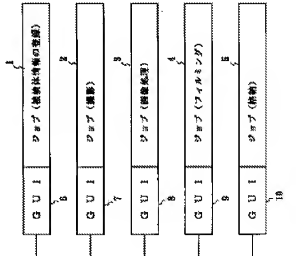
(57) Abstract

Objective

The objective of the present invention is to provide a medical image diagnostic device with good operability for a series of operation steps.

Means to solve

In a medical image diagnostic device, an operation designating means equipped with a display part and an operation part used for designating the conditions regarding the measurement and image display method has GUI 6-10 assigned to each job needed to obtain the measurement and diagnostic image and an editing/registration means that registers or edits a group of GUI as a job set obtained by arbitrarily combining jobs 1-5. In this way, it is possible to combine a series of operations conducted by the operator at will so that repeated operation can be avoided, and the operation efficiency can be improved. When GUI is adopted as the man-machine interface, the flow of the series of operations can be visualized to improve the operability.



Key: 1 Job (registration of the information of subject)
2 Job (image pickup)

3 Job (image processing)
4 Job (filming)
5 Job (storage)
7 Editing/registration means

[There are no amendments to this patent.]

Claims

1. A medical image diagnostic device having a measurement means that performs measurement in order to diagnose a subject, an image processing means that processes the measurement data obtained by said measurement means to obtain a diagnostic image, an operation designating means equipped with a display part and an operation part for designating the conditions related to the measurement and image display method, and a control means that controls the operations of said means, characterized by the fact that

said operation designating means has an interface means assigned to each measurement and diagnostic image job and an editing/registration means that combines the interface means at will and registers it as a job set or edits said job set.

2. The medical image diagnostic device cited in Claim 1, characterized by the fact that said interface means comprises a graphic user interface.

3. The medical image diagnostic device cited in Claim 1 or 2, characterized by the fact that said interface means has a condition setting means that sets the condition for each job and arbitrarily correlates it with other jobs.

4. The medical image diagnostic device cited in any of Claims 1-3, characterized by the fact that said job set has a hierarchically arranged structure, and the input of the information for the subject is assigned as the job at the top hierarchy of the job set.

Detailed explanation of the invention

[0001]

Technical field of the invention

The present invention relates to a medical image diagnostic device, particularly, a medical image diagnostic device with a modified man-machine interface.

[0002]

Prior art

Magnetic resonance imaging devices (referred to as "MRI device" hereinafter), X-ray CT devices, positron CT devices, and the like have been used as medical image diagnostic devices. As shown in Figure 5, the basic configuration of these devices comprises a measurement part 11 that performs measurement to diagnose a subject, an image processing part 12 that processes the

measurement data obtained by the measurement part to obtain a diagnostic image, and an external storage device 13 that stores the measurement data or the processed data.

[0003]

An operator may need to perform many complicated operations to obtain a diagnostic image by using the aforementioned medical image diagnostic devices. For example, the operator may need to input the information regarding the subject, select the image pickup method and type, select the image pickup location, perform image processing to the picked up or acquired image, store the acquired image in an external storage medium, print the image on a film for the acquired image (filming), select and reserve the next image pickup type, store the image of the subject whose image has been picked up in an external storage medium, perform the remaining operation of the filming processing or the like, and prepare to input the information regarding the subject whose image will be picked up next.

[0004]

These operations are carried out via interface part 20, that is, a console in the image diagnostic device. For example, jobs 21-25 displayed on a function selecting menu on the display part (not shown in the figure) of the console are selected. Here, job refers to the aforementioned operation conducted by the operator and the function performed by hardware based on that operation. It is used as conceptual software. These jobs are registered as individual protocols for each function. The operator sets conditions for executing the function according to the lower function selecting menu or condition setting menu for a selected job or selects a more subdivided function. When jobs 21-25 are set as described above, control part 1 can drive and control measurement part 11, image processing part 12, and external processing device 13 in accordance with the conditions.

[0005]

In the following, an example of the operation for MRI device will be explained. For example, the operations corresponding to jobs 21-25 are "registration of the information of subject", "image pickup", "image processing", "filming", "storage", and the like. These jobs are displayed on function selecting menu screen on interface part 20. The operator first selects "registration of the information of subject" from the function selecting menu in interface part 20 to enter and register the data regarding a subject. Then, the operator selects "image pickup" to select input of the information regarding the subject, the image pickup method and conditions and starts image pickup. Then, the operator selects "image processing" from the function selecting menu to select input of the information regarding the subject and the image pickup

method and conditions and sets the information for the previously set function (in this case "image pickup").

[0006]

Problems to be solve by the invention

As described above, in the conventional medical image diagnostic device, such as an MRI device, since protocols are registered individually for each function (job), the operator must repeatedly carry out the image pickup repeated for each subject and the accompanying operations. Even the operation procedure for the same function may have different conditions. The conditions may vary slightly because of the doctor's requirements or other factors. It is not possible to simply repeat the operations. The accompanying operations may be unnecessary. However, it may also be necessary to add new accompanying operations. The operator is required to deal with every situation appropriately to meet the aforementioned various demands.

[0007]

In addition, the operator must consider the time needed for the operation, the operation period, and the time margin when setting each operation procedure. Therefore, the operator must manage the entire series of operations. Therefore, even if the operations for individual functions, such as image pickup, are automated, a series of operations may be delayed because of the operator, or the operator may forget one of a series of operations.

[0008]

The objective of the present invention is to solve the aforementioned problem by providing a medical image diagnostic device that can improve the efficiency of the setting operation conducted by the operator in a series of operations for acquiring diagnostic image, can automate the flow of a series of operations, and can minimize interventions by the operator.

[0009]

Means to solve the problem

In order to realize the aforementioned objective, the present invention provides a medical image diagnostic device having a measurement means that performs measurement in order to diagnose a subject, an image processing means that processes the measurement data obtained by the aforementioned measurement means to obtain a diagnostic image, an operation designating means equipped with a display part and an operation part for designating the conditions related to the measurement and image display method, and a control means that controls the operations of the aforementioned means. The aforementioned operation designating means has an interface

means assigned to each measurement and diagnostic job and an editing/registration means that combines the interface means at will and registers it as a job set or edits the aforementioned job set.

[0010]

Preferably, the interface means comprises a graphic user interface (referred to as GUI hereinafter).

[0011]

As a preferred embodiment of the present invention, the interface means has a condition setting means (function) that sets the condition for each job and arbitrarily correlates it with other jobs. Also, preferably, the job set has a hierarchically arranged structure, and the input of the information for the subject is assigned as the job of the top hierarchy of the job set.

[0012]

In this case "job" refers to an operation unit obtained by subdividing the operation conducted by the operator of the medical image diagnostic device of the present invention and the hardware function based on said operation for each function. It includes the software used for carrying out each operation in the hardware. For example, a series of operations for acquiring a diagnostic image can be subdivided into image pickup, registration of information regarding the subject, image processing of the picked up image, filming processing, storage into external storage medium, and other jobs. Also, "interface means" refers to the intervention between the operator and a job for executing that job. One interface means is assigned to one job. GUI is preferred in consideration of the easiness of the visual grasping and good operability. Also, "job set" refers to a set of associated jobs. The combination and association of the jobs can be edited at will using the editing/registration means. The edited jobs can be registered.

[0013]

In this configuration, the operator selects an appropriate interface means corresponding to the image pickup conditions or the doctor's requirement. In this way, the conditions are set for the desired job, or the desired job is associated with other jobs. These jobs can be edited at will as a job set and can be registered as a job set.

[0014]

The jobs in the interface means are associated by defining the interface means (possibly a plurality of interface means) corresponding to the subsequent job in the interface means

corresponding to the preceding. In this case, the conditions of the previous executed job and the data of the execution results can be input and used as a reference when executing the job corresponding to the subsequent interface means.

[0015]

Also, the editing/registration means can register a series of jobs associated with each other as described above as a job set. Also, for some jobs in a job set, the conditions can be varied via the corresponding interface means, and the varied conditions can be used to form a new job set, thereby editing and registering the jobs at will. Consequently, if the interface means of several common types are formed and used to edit a job set, the repeated operation in a series of operations carried out repeatedly can be minimized.

[0016]

Also, when the top job in a hierarchical job set is set as a job regarding input of the information of a subject, a series of operations can be included in the subject unit. A series of operations can be repeated by only changing the information regarding the subject. Therefore, the operation can be facilitated.

[0017]

In the aforementioned medical image diagnostic device of the present invention, the operation conditions and sequence are designated by the control means that controls the entire device from the job set. In this way, it is possible to carry out automatic operation with minimal intervention from the operator.

[0018]

Embodiment of the invention

In the following, the medical image diagnostic device of the present invention will be explained based on an example of an MRI device.

[0019]

Figure 2 shows an application example of an MRI device to which the present invention is applied. This MRI device has the same hardware configuration as the conventional MRI device. It is equipped with, as measurement means, a static magnetic field generating system 101 that generates a spatially uniform static magnetic field in which a subject is disposed, an exciting system 102 that generates a radio-frequency magnetic field to generate nuclear magnetic resonance in the tissue of the subject set in the magnetic field, a tilted magnetic field generating

system 103 that generates a tilted magnetic field superimposed with the static magnetic field and having magnetic field strength varying linearly and independently in directions X, Y, Z, a reception system 104 that receives the radio-frequency signals generated from the subject under the irradiation of the radio-frequency magnetic field and performs A/D conversion on the signals, and probe 105 used for radio-frequency transmission and reception. It also has an image processing system 106 that performs various kinds of operations needed for image reproduction based on the measurement data sent from reception system 104, a sequence control system (control means) 107 that controls the operation timing of each system, an console 108 as the operation designating means, and a monitor device (not shown in the figure) for confirming the operations.

[0020]

The aforementioned MRI device is also equipped with an external storage device 109, such as magnetic disc, optical disc, or magneto optical disc (MO), used for storing the measurement data and the image data obtained after the processing is performed by image processing system 106 and an imager system 110 that substitutes the image data to a film or other medium for visually recording and displaying the image data.

[0021]

To pick up an image using the MRI device with the aforementioned configuration, several different methods, such as spin echo method or gradient echo method, can be used depending on the application (pulse sequence) of the radio-frequency magnetic field and the tilted magnetic field. Typically, a radio-frequency magnetic field pulse is first applied to the subject by exciting system 102 to excite a specific region of the tissue of the subject. Then, a tilted magnetic file is applied by tilted magnetic field generating system 103 to cause a phase change in the excited spin. In this case, the tilted magnetic field is used to provide spatial information to the measured signals. It is known as a phase encoding tilted magnetic field. In some cases, after a high-frequency magnetic field pulse is applied to reverse the spin, a read-out tilted magnetic field used for reading out the signal is applied. Meanwhile, the echo signal is detected by probe 105 and is measured by reception system 104. During that period, driving of exciting system 102, tilted magnetic field generating system 103, and reception system 104 is controlled by sequence control system 107, and measurement is performed using a prescribed pulse sequence.

[0022]

When the sequence from the spin exciting to the measurement of the echo signal is repeated while changing the strength of the phase encoding tilted magnetic field (phase encoding number), 2-dimensional measurement data are obtained as a group of the echo signals are used to obtain an image. If the phase encoding tilted magnetic field is applied along one more axis, three-dimensional measurement data can also be obtained.

[0023]

In image processing system 106, 2-dimensional Fourier transformation, calculation of correction parameters, image reconstruction, and other processing are carried out on the measurement data obtained by reception system 104. The processed data are stored as image data in external storage device 109 and are displayed as a tomogram on a display device, such as a display. Also, the data are converted into film by imager system 110.

[0024]

From the point of view of the operation conducted by the operator, the diagnostic image is obtained by using the MRI device as a result of various operations, such as "registration of the information of the subject", "image pickup", "image processing", "filming", and "storage". The operations are carried out via console 108.

[0025]

Therefore, for the MRI device disclosed in the present invention, the interface part (operation designating means) is constituted such that a series of operations from image pickup to data storage can be registered/edited as one protocol. For example, as shown in Figure 1, the interface parts are conceived of as operation units, that is, jobs obtained by subdividing "registration of the information of subject", "image pickup", "image processing", "filming", and "storage" for each function in the diagnostic image acquisition operation. GUI 6-10 (interface means) are assigned to jobs 1-5, respectively.

[0026]

Such a GUI, for example, can use the retrievable card-type graphic as shown in Figure 3. Said GUI 300 is displayed on the monitor device (not shown in the figure). Index part 301 illustrating the operation content is provided on the right side of card-type GUI 300, while condition setting section 302 that can describe the conditions for the job and definition section 303 for association with other GUI 300 are provided as condition setting means on the left side.

A description is input into said condition setting section or definition section 303 by using console 108.

[0027]

The various intrinsic information to be diagnosed for the subject is input, for example, by "registration of the information of subject" in condition setting section 302. In the case of "image pickup", in addition to the image pickup method, specific instructions indicating the image pickup parameters with which the image is picked up can also be described. In the case of "image processing", it is possible to select and set various kinds of processing, such as the maximal pixel projection method (MIP processing) for blood flow imaging or specification of the tomogram surface. In the case of "filming" that prints the picked up image on a film, it is possible to select the display of 2 rows in vertical direction and 2 rows in horizontal direction (2x2) or 3x3 display corresponding to the number of the obtained images. It is also possible to set the display sequence for multi-slice. In the case of "storage", it is possible to set the type of external storage device 109, such as magneto optical disc (MO), used for storing the obtained image data or to connect the medical image diagnostic device to a network. In this case, the network to which the image data are to be sent can be included.

[0028]

In general, GUI 300 corresponding to the next job can be defined by a prescribed method in definition section 303 in addition to the association relationship. In this case, the jobs are associated with each other by means of sequential processing or parallel processing. However, when one or more GUI is defined for one GUI, it is possible to establish a multi-layer association relationship.

[0029]

Job set 304 is formed by arranging said card-type GUI300 having condition setting section 302, definition section 303, and index part 301 in a plurality of hierarchies. Figure 3 shows a job set 304 formed by editing each GUI 300 in the order of registration of the information of subject, image pickup 1, image pickup 2, image processing 1, image processing 2, filming 1, filming 2, filming 3, filming 4, storage 1, storage 2, storage 3, and storage 4. For such a card-type GUI 300, the index part 301 of each GUI 300 is displayed in order from top to bottom on the right side of job set 304. The jobs are executed in that order.

[0030]

For example, in job set 304 shown in Figure 3, the image data picked up by image pickup 1 are processed by image processing 1, and the processing of filming 1 as well as the data storage of storage 1 are performed. Also, for the image data newly formed by image processing 1, the processing of filming 3 and the data storage of storage 3 are performed. Similarly, the image data picked up by image pickup 2 are processed by image processing 2, and the processing of filming 2 as well as the data storage of storage 2 are performed. Also, for the image data newly formed by image processing 2, the processing of filming 4 and the data storage of storage 4 are performed. The association between GUI 300 is shown by line 305 for the purpose of explanation in the figure. It is also possible to display the association relationship by using display section 306 provided above the index part 301 of each GUI 300. Of course, it is also possible to display by connecting with line 305 and lighting up as shown in Figure 3.

[0031]

GUI 300 associations as described above can also use the information of the preceding GUI 300 as reference. For example, in the case shown in Figure 3, when image pickup 1 is defined for filming 1 or storage 1, the information for the image pickup conditions for image pickup 1 can be used as reference without being described again for filming 1 or storage 1.

[0032]

The job set can be registered/edited by using keyboard, mouse, or the like used as console 108. In other words, it is possible to erase or add jobs at will by separating, combining, and editing any GUI 300. In this case, if there is no change in the conditions of the individual jobs, it is possible to register new operation sequence by simply reediting job set 304 without setting the conditions again. Also, if all of the operations are the same except for registration of the information of the subject, it is possible to repeat the series of operations in the same way by simply changing the GUI 300 used for registering the information of subject A to registering the information of subject B and registering it as job set 304. In this case, it is also possible to use GUI 300 with only some of the conditions changed to perform editing and registration. In this way, it is possible to easily handle the situation when the conditions are slightly different without repeating the entire series of operations.

[0033]

In the aforementioned configuration, the operator sequentially selects from GUI 6 to GUI 10 in accordance with a series of operations, that is, the flow of the jobs. The operator then sets the conditions for each job and associates them with each other, followed by registering these

jobs as a job set. If necessary, it is possible to easily pre-register several kinds of the aforementioned job sets. At the time of actual image pickup, a prescribed job set is selected. If there is no change in the series of operations starting from "registration of the information of subject" in its top hierarchy, followed by "image pickup", "image processing", "filming", and "storage", the hardware is started in accordance with the conditions set for that job set and the flow of the jobs. If conditions are changed in some of the jobs or there are changes in the jobs, the job set is edited, and the edited job set is registered as demanded, followed by starting the hardware. Consequently, if there is no change in the conditions or the like, and a series of operations can be carried out automatically in accordance with the pre-registered flow. Even if there are changes in the conditions or the like, it is only necessary to make partial changes via GUI 6 – GUI 10. And after that, the operation can be carried out automatically.

[0034]

As described above, a job set is a set in which a series of jobs are associated with each other either sequentially or in parallel. When starting an actual device, the information indicating whether a job is being executed or the device is in the idle state is important to the operator. Therefore, it is preferred that the interface part have a function displaying the status of progress. Figure 4 shows such an application example.

[0035]

The GUI shown in Figure 4 has an identification status symbol 307 indicating the progress status of the operation at the end of the index part 301 of the card-type GUI 300. For example, symbol D indicates the end of an operation, symbol R means that an operation is being carried out, and symbol N means that an operation has not been carried out (not shown in the figure). In job set 304 in which the operations are arranged in the order of registration of the information of subject, image pickup 1, image pickup 2, image pickup 3, image pickup 4, image processing 1, filming 1, storage 1, registration of the information of subject, image pickup 1, image pickup 2, and image pickup 3 have ended. Image pickup 4 is underway. Meanwhile, image processing 1 of the image data picked up by image pickup 1, filming 1 of the image data picked up by image pickup 2, and storage 1 of the image data picked up by image pickup 3 are being carried out.

[0036]

Depending on the aforementioned status identification function, the operator can tell the progress of the series of operations and which is the next operation to perform at a glance.

Instead of using said status identification symbol 307, the status identification function can also use the color of the GUI 300 display or a beeping or other sound.

[0037]

In the example shown in Figure 4, image processing 1 is associated with image pickup 1, filming 1 is associated with image pickup 2, and storage 1 is associated with image pickup 3 as indicated by lines 304. A series of operations can be carried out automatically without intervention from the operator. When the operations are carried out automatically as described above, as shown in Figure 4, the operations that cannot be carried out simultaneously can be carried out in parallel. Sequence control system 107 that receives the conditions from the job set and the support of the operation procedure determines whether operations can be carried out in parallel. For example, in Figure 4, image pickup 4, image processing 1, filming 1, and storage 1 can be carried out at the same time.

[0038]

GUI 300 disclosed in the aforementioned application example is of the card type. However, it can have any shape, such as button or icon. Also, a visible interface means that assigns each subdivided operation is used in the aforementioned application example, and GUI with good operability is used for the explanation. However, it is also possible to use character user interface (CUI).

[0039]

Also, an MRI device is explained in the aforementioned application example. The present invention, however, can be applied similarly to an X-ray CT device, positron CT device, and other general medical image diagnostic devices to improve the operability.

[0040]

Effect of the invention

In the aforementioned medical image diagnostic device of the present invention, the operation designating means has an interface means assigned to each measurement and diagnostic image job and an editing/registration means that combines the interface means at will and registers it as a job set or edits said job set. Therefore, the series of operations conducted by the operator can be combined at will. In this way, a series of operations carried out repeatedly from image pickup to storage of image data can be registered. In the case of performing operations of the same pattern, it is possible to carry out the operations efficiently without repeating the same setting. Therefore, not only individual operations but also a series of

operations can be carried out automatically without the intervention from the operator except for the initial setting, such as position alignment during image pickup. In this case, since operations that can be carried out in parallel can be carried out automatically in parallel, the throughput of the device can be improved.

[0041]

Also, when a GUI is used as the interface means, not only can each job be visually identified, the flow of the operation that constitutes the job set can also be visually displayed. In this way, the operability can be improved.

[0042]

In addition, when the interface means has a condition setting means that can set conditions for each individual job and associate the jobs constituting the job set at will, input of the common item and other repeated operations can be minimized in the series of operations.

[0043]

Moreover, when the job set has a hierarchical structure and the job in the top hierarchy (interface means) regards the input of the information of the subject, the operations can be performed using the unit of subject so that various kinds of procedures can be carried out efficiently.

Brief description of the figures

Figure 1 is a diagram illustrating the concept of registering a series of pre-set operations in the medical image diagnostic device disclosed in the present invention.

Figure 2 is a block diagram illustrating the configuration of an MRI device to which the present invention is applied.

Figure 3 is a diagram illustrating an application example of the GUI and job set in the MRI device to which the present invention is applied.

Figure 4 is a diagram illustrating another application example of the GUI and job set in the present invention.

Figure 5 is a diagram illustrating the operations needed for obtaining a diagnostic image using the MRI device.

Explanation of the reference symbols

1-4	Subdivided operation unit (job)
5-8	GUI (interface means)

9	Job set
101-105	Measurement means
106	Image processing means
107	Control means
108	Operation designating means

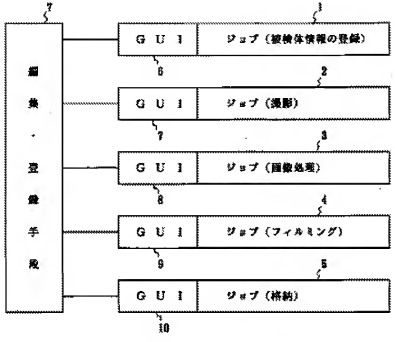


Figure 1

Key: 1 Job (registration of the information of subject)
2 Job (image pickup)
3 Job (image processing)
4 Job (filming)
5 Job (storage)
7 Editing/registration means

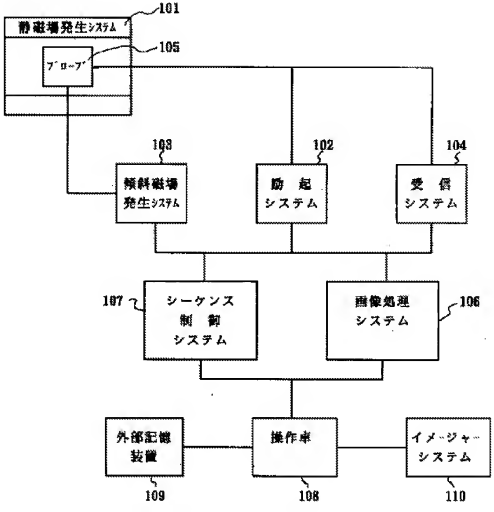


Figure 2

Key:
101 Static magnetic field generating system
105 Probe
102 Exciting system
103 Tilted magnetic field generating system
104 Reception system
106 Image processing system
107 Sequence control system
108 Console
109 External storage device
110 Imager system

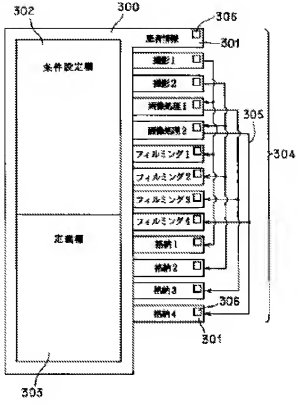


Figure 3

Key: 302 Condition setting section
303 Definition section
306 Patent information
Image pickup 1
Image pickup 2
Image processing 1
Image processing 2
Filming 1
Filming 2
Filming 3
Filming 4
Storage 1
Storage 2
Storage 3
Storage 4

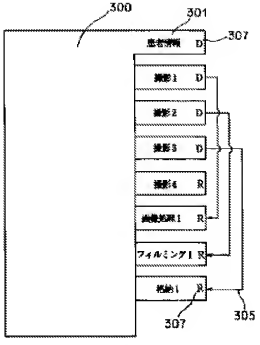


Figure 4

Key: 301 Patient information
Image pickup 1
Image pickup 2
Image pickup 3
Image pickup 4
Image processing 1
Filming 1
Storage 1

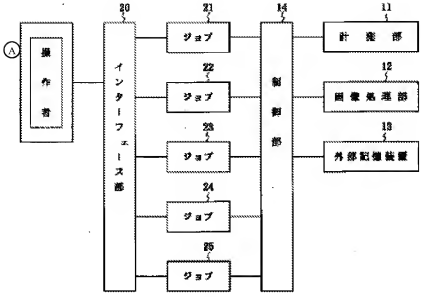


Figure 5

Key: A Operator
20 Interface part
21-25 Job
14 Control part
11 Measurement part
12 Image processing part
13 External storage device

Continued from front page

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